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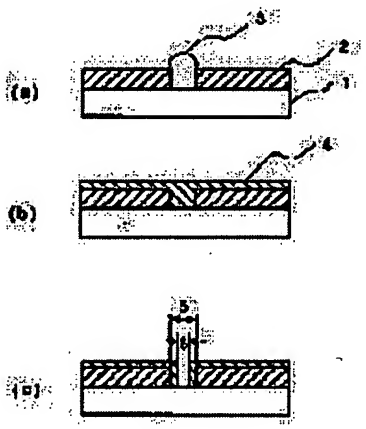
(54) PATTERN FORMING METHOD

(57)Abstract:
PURPOSE: To enable the formation of groove patterns and hole patterns to effectively smaller sizes and the formation of the fine patterns below the resolution threshold of lithography.
CONSTITUTION: The patterns are formed of a resist 2 contg. an acid generating agent which generates an acid by irradiation with energy rays. A chemical amplification type resist 4 which reacts to a negative type by utilizing the sensitization reaction of the acid is deposited thereon. The resist is subjected to a heat treatment in this state. The acid in the resist 2 is diffused at a specified depth to the resist 4 by the stage and is brought into reaction to the negative type. The resist is then subjected to development processing, by which the excess resist not reacting to the negative type is removed.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the lithography technique in manufacture of a semiconductor device, a magnetic-bubble device, a surface acoustic wave device, etc., and relates to the method of forming a detailed pattern especially.
[0002]
[Description of the Prior Art] High accumulation and densification of ULSI are advanced with 4 times as many vigor as this in 3, and fertilization of 4-megabit DRAM and the prototype of a 16 megabit DRAM are already made. The dimension required of micro processing in connection with this is 0.8 micrometers to 0.5 micrometers, and 0.3 more micrometers. It is increasingly made detailed to the following.
[0003] At the usual optical lithography used as the lithography method being in use, it is 0.3 micrometers. Formation of the following patterns is becoming difficult. However, resolution improves sharply by adoption of a phase shift method in recent years, and it is 0.3 micrometers. Formation of the following patterns also became possible. However, this approach is the approach of improving resolution by giving phase contrast to the transmitted light between the patterns with which each other was adjoined in the photo mask, and the effectiveness of a phase shift is not enough acquired by isolated pattern like the contact hole for the electrode ejection of a semiconductor device. Thus, the design of the component for which it is inadequate for and balance was able to take detailed-ization of an isolated pattern with the conventional technique was difficult.
[0004] In addition, as a method of forming a detailed pattern, after forming a resist pattern with lithography, the approach of forming the film for dimension amendment alternatively is shown in the resist pattern side attachment wall at JP,63-131522,A. By using this approach, by the resist pattern, when the hole pattern formed greatly also forms the film for dimension amendment, detailed-izing is possible and pattern formation below the resolution limit can be performed. However, this approach has a complicated process and it is difficult to apply to production of a component.
[0005]
[Problem(s) to be Solved by the Invention] The purpose of this invention fattens the pattern formed with lithography in self align, and is to make the dimension of a slot pattern or a hole pattern detailed effectually, and a process is especially to offer a simple approach.
[0006]
[Means for Solving the Problem] The above-mentioned purpose can be attained at the following processes using the description of the resist ingredient of chemistry magnification (catalyst) reaction use. A pattern is formed by the 1st resist which contained the acid generator which generates an acid by the exposure of an energy line. The 2nd resist of the chemistry multiplier system which moreover reacts to a negative mold using the sensitization reaction of an acid is put. It heat-treats in this condition. According to this process, the acid in the 1st resist carries out fixed depth diffusion at the 2nd resist. Therefore, it reacts to a negative mold with the acid which the 1st resist and the 2nd resist near the 2nd resist interface

have diffused. Next, the excessive resist which has not reacted to a negative mold is removed by performing a development. Of the above process, the 2nd resist of fixed thickness is alternatively formed in the surroundings of the 1st resist pattern.

[0007]

[Function] The diffusion depth of the acid from the 1st resist to the 2nd resist is decided by the conditions of heat treatment after putting the 2nd resist. That is, the thickness of the 2nd resist which finally remains in the surroundings of the 1st resist pattern is decided. The thickness of this 2nd resist serves as film which amends the dimension of a pattern. For example, when the dimension of the hole pattern formed by the 1st resist pattern remains around a pattern by 0.5 micrometers by the thickness whose 2nd resist is 0.1 micrometers, the dimension of an effectual hole pattern is 0.3 micrometers. It becomes and large detailed-ization can be attained.

[0008]

[Example] The 1st example of this invention is explained using drawing 1 . As shown in drawing 1 (a), the positive resist 2 which contained the acid generator which generates an acid by the exposure of an energy line was put. Then, the hole pattern 3 was formed by the usual exposure development. And powerful far ultraviolet rays were irradiated and surface hardening processing in which the front face of a resist pattern was stiffened was performed so that a positive resist 2 might not begin to have melted with the solvent of the resist 4 applied to a degree. However, when it is the combination of the ingredient into which a positive resist 2 does not begin to melt with the solvent of a resist 4, the process which stiffens a resist pattern front face is unnecessary. Then, ultraviolet rays were irradiated, the acid generator in a positive resist 2 was decomposed, and the acid was generated. This UV irradiation may be performed before resist hardening.

[0009] Then, as shown in drawing 1 (b), the negative-mold chemistry multiplier system resist 4 using the sensitization reaction of an acid was applied to the whole surface. Although an acid generator does not need to be contained into this resist, it does not interfere, even if the acid generator is contained. Then, the acid in a positive resist 2 was diffused in the negative-mold chemistry multiplier system resist 4 by heat treatment. Thereby, the chemistry multiplier system resist 4 near an interface with a positive resist 2 reacted to the negative mold. Then, the usual development of a negative-mold chemistry multiplier system resist was performed.

[0010] Thereby, as shown in drawing 1 (c), the negative-mold chemistry multiplier system resist 4 remained by uniform thickness around positive-resist 2 pattern. According to this process, the dimension 6 smaller than the dimension 5 of the hole pattern 3 formed first was able to be obtained.

[0011] The 2nd example of this invention is explained. The difference with the 1st example is a point which formed the first resist pattern 2 by negative resist, and can skip the UV irradiation process for acid generating at a subsequent process. When the first resist pattern 2 is negative resist, in order that the UV irradiation section may remain as a pattern, an acid is formed of the UV irradiation for pattern formation. Therefore, the UV irradiation for acid generating in the 1st example is unnecessary. However, it may be better to add the UV irradiation process for adding generating of an acid depending on the combination of a resist. Other processes were the same as the 1st example, and were equivalent.

[of the obtained result]

[0012] The 3rd example of this invention is explained using drawing 2 . As shown in drawing 2 (a), the organic film 7 which is the lower layer ingredient of a two-layer resist was put on the processed substrate 1. Then, the resist 8 which contained the acid generator which generates an acid by the exposure of an energy line was put. After an appropriate time, the hole pattern 9 was formed by the usual exposure development. Powerful far ultraviolet rays were irradiated and surface hardening processing in which a resist pattern front face was stiffened was performed so that a resist 8 might not begin to have melted with the solvent of the resist 10 applied to a degree after an appropriate time. However, when it is the combination of the ingredient into which a resist 8 does not begin to melt with the solvent of a resist 8, the process which stiffens a resist 8 pattern front face is unnecessary. After an appropriate time, ultraviolet rays were irradiated, the acid generator in a resist 8 was decomposed, and the acid was generated. This UV irradiation may be performed before resist hardening.

[0013] As shown in drawing 2 (b) after that, the silicon content resist 10 of the negative-mold chemistry multiplier system using the sensitization reaction of an acid was applied to the whole surface. Although an acid generator does not need to be contained into this resist, it does not interfere, even if the acid generator is contained. Then, the acid in a resist 8 was diffused in the resist 10 by heat treatment. Thereby, the resist 10 near an interface with a resist 8 reacted to the negative mold. Then, the development was performed.
[0014] Thereby, as shown in drawing 2 (c), the resist 10 remained by uniform thickness around resist 8 pattern. According to this process, the dimension 12 smaller than the dimension 11 of the hole pattern 9 formed first was able to be obtained.
[0015] Then, as shown in drawing 2 (d), the organic film 7 was processed by the reactant dry etching using the reactant gas containing oxygen. According to this process, the detailed dimension 12 has been imprinted on the organic film 7.
[0016] The 4th example of this invention is explained using drawing 3 . As shown in drawing 3 (a), the resist containing the acid generator which generates an acid, or the resist 13 containing an acid was put by the exposure of an energy line as a lower layer ingredient of a three-layer resist on the processed substrate 1. Moreover the inorganic film 14 was put, on it, the resist 15 was put and the pattern 16 was formed by the usual approach.
[0017] Then, as shown in drawing 3 (b), like the usual three-layer resist method, by reactive ion etching, the pattern was imprinted in the lower layer and the pattern of a dimension 17 was formed one by one.
[0018] Then, as shown in drawing 3 (c), the negative-mold chemistry multiplier system resist 18 was applied. Although an acid generator does not need to be contained into this resist, it does not interfere, even if the acid generator is contained. Then, the acid in a resist 13 was diffused in the resist 10 by heat treatment. Although the acid generator in a resist 13 reacted by the exposure of the energy line in a reactive-ion-etching process etc. and the acid is generated at this time, to be inadequate, it is necessary to add the exposure process of an energy line before heat treatment. Then, the development was performed.

[0019] Thereby, as shown in drawing 3 (d), the resist 18 remained on the side attachment wall of resist 13 pattern. According to this process, the dimension 19 smaller than the dimension 17 of the hole pattern 16 formed first was able to be obtained. In the example, the resist 13 and the resist 18 used the same ingredient. A resist ingredient can use the chemistry multiplier system resist SAL601 (the Shipley Far East company make), chemistry multiplier system negative-mold photoresist THMR-i100 (Tokyo adaptation make), etc.
[0020]
[Effect of the Invention] According to this invention, after forming a resist pattern with lithography, a resist pattern is fattened in self align, it is possible to make the dimension of a slot pattern or a hole pattern detailed effectually, and the detailed pattern below the resolution limit of lithography can be formed.

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CLAIMS

[Claim(s)]
[Claim 1] The process which forms the resist pattern containing the acid generator which generates an acid by the exposure of an energy line on a processed substrate, The process which puts the resin which insolubilizes under existence of said acid, the process which diffuses said acid to said resin which insolubilizes under existence of said acid from said resist pattern which contained said acid generator by heat treatment, The pattern formation approach characterized by including at least the process which removes said resin which insolubilizes under existence of said acid which has not diffused said acid by development.
[Claim 2] The pattern formation approach of having established the process which prevents mixing of both resists between the process which forms said resist pattern which contained said acid generator which generates said acid by the exposure of said energy line in claim 1, and the process which puts said resin which insolubilizes under existence of said acid.
[Claim 3] The pattern formation approach which consists of ingredients with which said resist which contained said acid generator which generates said acid by the exposure of said energy line in claim 1, and said resin which insolubilizes under existence of said acid do not melt together mutually.
[Claim 4] The pattern formation approach of having established the exposure process of said energy line after the process which forms said resist pattern which contained said acid generator which generates said acid by the exposure of said energy line in claim 1.
[Claim 5] By the exposure of the process which forms the multilayer-resist lower layer film on a processed substrate, and an energy line The process which puts the resin which has oxygen-proof plasma-etching properties, such as a process which forms the resist pattern containing the acid generator which generates an acid, and silicon content which insolubilizes under existence of said acid, By reactive ion etching using the process which diffuses an acid to said resin from said resist pattern which contained said acid generator by heat treatment, the process which removes said resin which has not diffused an acid by development, and the etching gas containing oxygen The pattern formation approach which includes at least the process which imprints a pattern in the lower layer film.
[Claim 6] The using [on claim 1 and] at least one of acid generators, such as onium salt [for example,], sulfonate, and halogenated compound, pattern [acid generator / said] formation approach.
[Claim 7] The pattern formation approach that said resist pattern which contained said acid generator which generates said acid by the exposure of said energy line is formed by the lower layer resist of a multilayer resist on said processed substrate in claim 1.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The sectional view in each main processes which show the 1st and 2nd examples of this invention.
[Drawing 2] The sectional view in each main processes which show the 3rd example of this invention.
[Drawing 3] The sectional view in each main processes which show the 4th example of this invention.
[Description of Notations]
1 -- 2 A processed substrate, 3 -- The resist, 4 containing the acid generator which generates an acid -- Chemistry multiplier system negative resist.

[Translation done.]